The path along which they walk is a path which they did not engineer. It is a path made for them, and they simply follow it. But the propensities and tastes and feelings which make them follow it, and the rightness of its direction towards the ends to be obtained, do constitute a unity of adjustment which binds together the whole world of Life, and the whole inorganic world on which living things depend.

I have called this adjustment mechanical, and so, in the strictest sense, it is. We must take care, however, not to let our conceptions of the realities of Nature be rendered indistinct by those elements of metaphor which abound in language. These elements, indeed, when kept in their proper places, are not only the indispensable auxiliaries of thought, but they represent those perceptions of the mind which are the highest and the most absolutely true. They are the recognition—often the unconscious recognition—of the central unities of Nature. Nevertheless, they are the prolific source of error when not closely watched. Because all the functions and phenomena of Life appear to be strictly connected with an apparatus, and may therefore be regarded as brought about by adjustments which are mechanical, therefore it has been concluded that those phenomena, even the most purely mental, are mechanical in the same sense in which the work is called mechanical which human machines perform. Are not all animals "automata?" Are they not "mere machines?" This question has been revived from age to age since philosophy began, and has been discussed in our own time with all the aid which the most recent physiological experiment can afford. It is a question of extreme interest in its bearing on our present subject. The sense in which, and the degree to which, all mental phenomena are founded on, and are the result of mechanical adjustments, is a question of the highest interest and importance. The phenomena of instinct, as exhibited in the lower animals, are undoubtedly the field of observation in which the solution of this question may best be found, and I cannot better explain the aspect in which it presents itself to me, than by discussing it in connection with certain exhibitions of animal instinct which I had occasion to observe during the spring and summer of 1874. They were not uncommon cases. On the contrary, they were of a kind of which the whole world is full. But not the less directly did they suggest all the problems under discussion, and not the less forcibly did they strike me with the admiration and the wonder which no familiarity can exhaust.

IMPROVEMENT OF THE MISSISSIPPI RIVER.*

By Prof. W. H. Ballou.

The Mississippi River is the most gigantic parasite known to men. The least possible estimate, computed from data in hand, shows that the annual average for the last thirty years, of money expended on it for improvements, and lost through its depredations, exceeds $7,000,000. Fully one-third of this sum is used by the government, States and private individuals to keep the stream and its tributaries in an "improved condition." The table will show the average of the expenditures obtained for the last thirty years :

Expenditures of the States of Mississippi, Louisiana and Arkansas on levees since 1849	$100,090,000
Expended by the government and private individuals—estimate	50,000,000
Damage by floods, ice gorges, etc., to levees, property, life etc.	80,000,000
Total	$230,090,000
Average per annum, $7,669,666.	
To this may be added 26,772,379 acres of land granted to the above States by the government in 1849, the value being about $10 per acre	267,773,790
Total	$497,813,790
Average per year, $16,000,000.	

Only those who are acquainted with the stream and its peculiarities have an idea how unmanageable it is. The unstable condition of the soil of the country through which it flows renders it an object of distrust to the inhabitants of its border. Such is the treacherous condition of its relations that for sixty-two years the ingenuity of man has contrived no check on its action. The causes of this condition of things are found partly in the river-bed. The sedimentary deposit varies from 60 to 100 feet in depth. It is generally composed of silt, with a mixture of clay and sand, which, having been deposited by the river, is at its disposal to lie still or be shifted about. It is evident that no ordinary construction can long stand unless it has a foundation penetrating this bed to a rock stratum. The great bridge at St. Louis, for instance, has its piers resting on the limestone bed-rock, under a sedimentary deposit of seventy feet. The railway bridge at the mouth of the Minnesota river has its piers lodged on a slender stratum of hard earth sixty feet beneath the river's bottom. It is further admitted that in boring through this stratum a soft layer was struck, which would not uphold the rod's weight. At Cairo, Ill., in 1877, the United States corps of engineers, under Lieutenant D. W. Lockwood, made borings to a depth of 87 feet without encountering any stratum harder than sand. At this point the machinery broke down and operations were suspended. At a depth of 33 feet the auger penetrated a cottonwood log, hardly ready to decay, showing conclusively the facility with which the river makes its own bed. At the same place it is stated on good authority that piles, one on another, have been driven to a depth of 125 feet without encountering a rocky stratum.

The story of its great width is even more remarkable. Near Cairo, Ill., the river moved a mile out of its course in one year, and is continually changing at that point. Still more remarkable are the operations of the Missouri river. At one time Council Bluffs enjoyed its presence in the immediate proximity, and the benefits of its commerce, in consequence of which the city became the terminus for Western railways in preference to Omaha, three times its size. These railroads erected depots and stationed offices of general Western superintendents there. The Union Pacific constructed an immense bridge, and in common with other railways built a union depot at the Bluffs. No sooner was the work completed, than the Missouri performed the rare feat of moving its course to Omaha, three miles away. There is no end to instances of this kind on a smaller scale. It may be safely asserted that from its narrowest point the Mississippi varies to twenty miles in width. It is no wonder, then, that the present embankment system is inadequate. Appropriations are only asked at present for embankments as far north as Cairo. It is evident, however, that the sedimentary bed extended nearly to the source of the Mississippi, and that not only must the 110 miles from New Orleans to Cairo be embanked, but also the greater shore line above the latte city on both this river and the Missouri. An explanation of the frequent destruction of levees, dikes and embankments is found in the method of their construction. When the current leaves the middle and runs along one side of the stream, the bank is rapidly torn down. At this point the corps of engineers proceed to build a dike to resist the destructive force. A rip-rap is first constructed which consists of a raft covered with long poles, placed cross-wise in alternate layers. This is loaded with heavy stones and sunk near the shore. Outside of it long poles are driven to a depth of twenty or thirty feet, and sometimes to twice these depths. Brush and stones are heaped upon their foundation until a perpendicular embankment is completed on a level with the top of the bank. One would think that this ponderous dike would stand for ages. But so vaccillating is the silt bed underneath that the water keeps working the outer edge with powerful results. The embankment settles, sometimes toppling over, and again dropping suddenly from sight. Often the water works in behind these constructions and leaves them out in the stream. Thus it happens that the river is at work at innumerable points, tearing away its banks and defying the structures in use to hold it in check.

In its work of destruction the current has some formidable aids. In the winter ice floats down continually. So immense are these cakes at times that three, and even two coming down stream abreast will get caught on the sides of the river, in some narrow channel, and form a bridge. This bridge effectually holds back all oncoming ice. The great and small cakes coming down in large quantities join under, over and behind the bridge, piling up to a great height, forming a gigantic gorge. This mass finally breaks away ; no power yet inaugurated by the hand of man is able to withstand it. Embankments, boats, live stock, people,

* Read before the A. A. A. S., Boston, 1880.

forests, houses, other property are borne down stream. One gorge alone has been known to sweep away $3,000,000 worth of property, besides making a tremendous destruction of life. A gorge will often require three days to pass a given point.

Another enemy to investigation and to embankments are the snags which infest the river. These, in their worst form, are large trees with roots and limbs. So rapidly are they loosened and borne down that the government is required to keep several snag boats constantly at work. Perhaps the greatest of all enemies to embankments is the period of high water. At this time most of the country adjoining the river, known as the " bottom lands," is flooded to a greater or less depth. This is a most dangerous period, the result of which is awaited with anxiety by land-owners involved. The various floods occurring since 1850, principally in that year, and those of 1864 and 1874, have carried away 200 miles of embankment between New Orleans and Cairo alone, which will cost the government alone $6,000,000 to repair.

There are many schemes offered for the construction of permanent embankments. Some are practicable to an extent, and others are but empty air. It is evident, however, that the government can never secure sufficient funds to inaugurate a system of embankments which shall have a foundation resting on the bed-rock below the river's bottom. Captain Charles M. Scott proposes a method which is, in brief, to weight and sink a reach of trees with their roots in such a manner as shall change or keep the current within bounds. A careful consideration of this method shows that after every high-water season these trees would be "reaching" in all directions along the river. Captain James B. Eads once proposed a system of ditches which shall narrow the river in wide places and compel the current to cut a deeper channel. As I understand this method, it is hardly practicable. There are other methods proposed. That of Captain Cowden is, perhaps, worthy of trial, though I am compelled to believe that it must be accompanied by a permanent system of levees. A very simple method, which has a semblance of practicability, is being experimented on near Omaha and at Nebraska City by Major C. R. Suter. An examination of this exhibits a simplicity which may circumvent the action of the water. No rip-rap is sunk and no piles are driven down. The sloping bank is covered with a mattress of brush. Stones are piled on this to a thickness of seven or eight feet, which holds the bank in its place and retains its sloping form. The water seems to have little inclination to work under this as in the case of a perpendicular embankment. I believe it is the invention, for the most part, of Professor L. E. Cooley, late professor of Engineering in the Northwestern University at Evanston, Ill., and now in charge of the works at Nebraska City, Major Suter also employs a simple and inexpensive method of changing the current of the river where it is wearing away the bank. A line is fastened to a buoy near the centre. Branches of trees are tied along one-half of this, leaving the other half bare. Anchors are attached at both ends of the rope and the half without bushes is run up the river as a guy, while the buoy holds up the centre of the rope at the surface. A line of brush then runs from the surface diagonally to the bottom. A series of these is placed out in the stream near where the damage is being done. The sediment coming down stream catches on the brush, sinks and forms a bar, and either breaks the force of the current or throws it out into the stream away from the endangered bank. This latter method has long been in use by the Corps of Royal Engineers with success.

Hegar's formula for an effective non-poisonous preservative and antiseptic is as follows :

R	Salicylic acid	20 parts.
	Boracic acid	25 "
	Potassium carbonate	5 "
	Dissolve in hot water	500 "
	Glycerine	200 "
	Then add oil of cinnamon, oil of cloves, each 15 parts, dissolved in alcohol	500 "

It is an exterminator of moths and vermin and has a pleasant odor.

ON THE NUTRITIVE VALUE OF FISH.*

By Prof. W. O. Atwater.

This paper gives the results of an investigation made under the auspices of the Smithsonian Institution and the United States fish commission. They included analyses of a large number of specimens of more common food fishes, whose details, though quite extended, were mainly of theoretical value. Some of the applications, however, were of much practical interest. In 100 pounds of the flesh of fresh cod we have 83 pounds of water and only 17 pounds of solids, while the flesh of the salmon contains only 66½ per cent. of water and 33½ per cent. of solids ; that is to say, about one-sixth of the flesh of cod and one-third of that of salmon consists of solid, that is, nutritive substances, the rest being water. Lean beef, free from bone, contains about seventy-five per cent. water and twenty-five per cent. solids. The figures for some of the more common sorts of fish were :

	Solids. per cent.		Solids. per cent.
Flounder	17.2	Halibut, fat	30.7
Cod	16.9	Mackerel	22.2
Striped bass	20.4	Shad	30.7
Bluefish	21.8	Whitefish	30.4
Halibut, lean	20.6	Salmon	33.6

If we take into account not the flesh only but the whole fish as sold in the market, including bones, skin and other waste, the actual percentages of nutritive material, is, of course, smaller. Thus the following percentages of edible solids were found in samples analyzed :

Flounders	7.1	Shad	14.8
Cod	10.5	Shad	18.7
Mackerel	11.4	Lake trout	13.6
Halibut, lean	15.6	Salmon	25.6
Halibut, fatter	27.2		

The subject has of late attracted unusual attention. The chemico-physiological investigation of the past two decades has brought us where we can judge with a considerable degree of accuracy from the chemical composition of a food-material what is its value for nourishment as compared with other foods. The bulk of the best late investigation of this subject has been made in Germany where a large number of chemists and physiologists are busying themselves in the experimental study of the laws of animal nutrition. They have already got so far as to feel themselves warranted in computing the relative values of our common foods, and arrange them in tables, which are coming into popular use. The valuations are based upon the amounts of albuminoids, carbo-hydrates and fats, each being rated at a certain standard, just as a grocer makes out his bill for a lot of sugar, tea and coffee, by rating each at a certain price per pound, and adding the sums thus competed to make the whole bill. A table was given showing the composition of a list of animal foods. Thus it appeared that, while medium beef has about three-fourths water and one-fourth solids, milk is seven-eighths water and one-eighth solids. Assuming a pint of milk to weigh a pound, and speaking roughly, a quart of milk and a pound of beefsteak would both contain the same amount—about four ounces—of solids. But the quart of milk would not be worth as much for food as the pound of steak. The reason is that the nutrients of the steak are almost entirely albuminoid, while the milk contains a good deal of carbo-hydrates and fats, which have a lower nutritive value. According to the valuations given, taking medium beef at 100, we should have for like weights of flesh free from bone :

Medium beef	100.0	Bluefish	85.0
Fresh milk	23.8	Mackerel	86.0
Skimmed milk	18.5	Halibut	88.c
Butter	124.0	Lake trout	94.0
Cheese	155.0	Eels	95.0
Hens' eggs	72.0	Shad	99.0
Cod (fresh fish)	68.0	Whitefish	103.0
Flounders	65.0	Salmon	104.0
Halibut	88.0	Salt mackerel	111.0
Striped bass	79.0	Dried codfish	346.0

These figures differ widely from the market values. But we pay for our food according, not to their value for nourishing our bodies, but to their agreeableness. Taking the samples of fish at their retail prices in the Middletown, Conn., markets, the total edible solids in striped bass came to about $2.30 a pound, while the Connecticut river shad's

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